A CLINICAL STUDY OF SOME REFLEXES.*

By Joseph Fraenkel, M.D.,
Physician in charge of the Montefiore Home for Chronic Invalids;
Neurologist to the New York City Hospital.
AND
Joseph Collins, M.D.,
Professor of Nervous and Mental Diseases in the Post-Graduate Medical School, Visiting Physician to the New York City Hospital.

This inquiry into the nature and significance of some of the more important reflexes is based upon upward of three thousand recorded examinations made upon healthy and sick persons in the Montefiore Home, and in our clinic for nervous diseases at the Post-Graduate Medical School. About two-thirds of the entire number of persons investigated were sufferers with nervous diseases.

The first object of the study was to determine, if possible, the physiological nature of those reflexes called tendon phenomena, and to inquire into their relationship to, and probable dependence upon, muscle tone. Another object was to ascertain the behavior of tendon jerks under repeated stimulation by a blow sufficient to elicit the jerk; in other words, to determine the exhaustibility of the tendon reflex. Finally the relation between deep and superficial reflexes was studied, and the claim recently put forward in regard to the semeiological significance of the plantar reflex was investigated.

The examinations were made in the following order: Two hundred and ninety individuals were examined with a tonometer, which measures the tonicity of the Achilles tendon. This instrument was devised by Dr. L. J. J. Muskens, a former assistant in the clinic, who published a description of it in the *Neurologisches Centralblatt*, December 1, 1899.

With this instrument sixteen measurements were made on each foot; that is, thirty-two on each patient, then the average mean of this number was taken to represent approximately the tone of the muscles.

The following topics were selected for particular investigation:

---

*Abstract of a paper read before the American Neurological Association, May 1, 1900.

1. The state of tension of the patellar tendon, determined empirically by palpation.
2. The knee-jerk. The blow to elicit this was struck first with the hand and then with the hammer, while the knees were crossed, uncrossed, and with and without reinforcement, each test being made ten times in succession.
3. The Achilles jerk. This was examined in the following manner: The foot was placed on the floor in such a position that the examiner had sufficient space to swing the hammer in order to give the tendon an effectual blow, while the position of the examiner was such that he could see the quadriceps muscle contract, and at the same time observe the amount of locomotion produced by the contraction. In this way both phenomena, the contraction of the muscle as well as the locomotion of the foot, were seen and studied, while the speed of the other reactions were also observed.
4. The plantar reflexes were selected for most extensive observation, not only because they are the most constant of the skin reflexes, but because they fairly represent the type of such reflexes. In the first group of examinations the object was to ascertain the inter-relationship of tendon and skin reflexes. Another series of examinations was made for the purpose of ascertaining the speed of the tonus reflex or the reaction time, particularly that part of the tonus constituting the reflex act.
5. Finally, in every patient the mechanical irritability of the quadriceps muscle, as elicited by percussion, as well as the speed and quality of this reaction was determined.

The first matter for consideration is the relationship between the tendon reflex and muscle tone as determined by the tonometer. As a preliminary observation it is necessary to say that the question of the existence of muscle tone and its influence upon the tendon reflex is a mooted question with both clinicists and physiologists. It may be objected by some that our statements concerning muscle tone are based on examinations of the Achilles tendon, and that the result of these findings are applied to the state of the patellar reflex. In response to this we say that there is no valid objection to the assumption that the results of these measurements may not be taken as a reliable index of general muscle tonicity.

The tonometric figures in all the cases may be divided into three groups: First, Those ranging from 17 to 27, which are referred to as cases with large tonometric figures; second, those from 12 to 17, medium tonometric figures; and third, those below 12, as small tonometric figures. Those with figures from 12 to 17 may be looked upon as representing the average of physiological tonus. All figures above this may be called evidences of hypotonus, while the figures below it may be considered indicative of hypertonus.

The first point for consideration was to determine if there was any exaggeration of knee-jerks, with large tonometric figures. Of the cases with large tonometric figures the knee-jerk was absent in 16 cases: 14 of tabes, one of Friedreich's ataxia, and one of peripheral neuritis. It was diminished in 15 cases. We speak of it as diminished when the Jendrassik method had to be employed or the knee-jerk had no locomotion. In twenty cases it was lively or normal.

The highest tonometric figures in the group with high figures are found in those in which the reflexes were absent, but not in all. This rather surprising finding is explained by the fact that those patients were confined for a long time to a chair or bed, and that the tendon was soft, atrophied, and close to the bone, so that the rod of the tonometer was pressed against bone, and not against tendon.

The group of cases with diminished reflexes represents all kinds of internal diseases. It is made up mostly of scrofulous and phthisical patients, the latter with evidences of amyloid degeneration, and those with functional nervous diseases, neurasthenia and hysteria of the gastro-intestinal variety.

After finishing with this large group, we must consider the hypertonic group. We find a very small number, viz., 22, with absent or diminished reflexes, the remainder showing either normal or exaggerated reflexes. Eighteen show increase of knee-jerks and ankle-clonus. From the group that showed exaggerated reflexes we select first, those that not only had exaggerated knee-jerks, but ankle-clonus as well, 18 in number. They all represent cases of diseases of the pyramidal tracts, one sided or both sided, with one exception, which was a case of paralysis agitans. So that great value is attached to them, particularly those in which the disease was one sided, as well as in those in which there is a very distinct difference between the diseased side and the healthy side, in that the side upon which the disease existed showed at the same time smaller tonometric figures.

It now becomes necessary to explain the twenty-two cases with diminished or absent reflexes. The first point that attracts our attention is that this group contains a number of cases of tabes, viz.: 7. The majority of the patients making up the group with diminished reflex, however, were muscular, robust and healthy individuals. One case was that of a patient with paramyoclonia, a disease characterized by a state of exalted muscle tone. In another case there was a cardiac lesion, with incompetency, and so much edema of both the knee and the ankle that neither tendon could be reached so as to apply the tonometer. In another case the same difficulties arose from edema produced by liver disease. In still another case, with disease of the pyramidal tract, our notes state that the tonometric figures and the behavior of the reflex could not be got nor a reliable examination made, owing to the incessant tremor or clonus. In still another case the patient could not be made by any means to relax the tendon. A similar statement applies to other neurasthenic and excitable patients, and so there is finally left only two cases to explain; one with an aortic insufficiency, in which no apparent reason could be given why the reflexes were diminished; and another extremely interesting case, a case of a tumor of the left cerebellar hemisphere, found by autopsy, in which the measurements were taken in bed on various occasions, and were found to differ on every examination. At one time the hypotonus would be excessive, and the reflex not elicitable, and at another time the tonus increased and the reflex lively, the ankle-clonus being easily elicitable.

In the group with small tonometric figures there were a number of patients with lively or slightly diminished reflexes, which call for no further explanation. In this group, with tonometric figures of from 12 to 17, we find either lively or somewhat lessened reflexes, depending upon whether the figures are nearer to the upper or to the lower limit.

In general and in brief, it may be stated that with increased muscle tone there is increase of tendon reflexes up to a point of pseudo-clonus, and with diminution of muscle tone there is a diminution of the tendon jerk up to a point of apparent disappearance. When the increase of the reflex has progressed so far as to give rise to a genuine ankle-clonus, or decreased so far as to lead to total abolition of the reflexes, there are other and additional factors than increase or diminution of muscle tone to be found in explanation of it: such as purely neural factors, like disease of the pyramidal tracts or disease of the posterior columns.

From the foregoing, the inference seems justified that tendon reflexes are not elementary, but complex phenomena. Their existence is dependent upon at least two, perhaps only two, factors. First, the state of nutrition and the reaction of the muscle to proper stimulus, and secondly, the state of the reflex arc carrying and bringing the nerve supply to the muscle. That this is true is very evident when our tables are consulted, which show the relationship between tonus reflex and mechanical muscular irritability. It was found that whenever the diminution of the reflex was due to a disease of the neural elements the muscular irritability was found to be increased; when, on the other hand, it is due to an interference with those factors themselves—the state of nutrition and tonus of the muscle—the mechanical muscular irritability was diminished, vermicular and sluggish. This is particularly evident in the cases of tabes, in which our examinations showed, without exception, the curious phenomena that the quadriceps muscle struck at its tendon gives no response, while the same blow applied to the belly of the muscle is followed by quick and vigorous contraction.

Empirically, by means of percussing the patellar or Achilles tendon an approximate estimate of the state of tension of a given tendon can be made, although not so exact as with the instrument. When action is exerted during the examination and the patellar tendon examined while the patient's foot rests on the floor, the leg forming a right angle with the thigh, the patient thus reclining comfortably, while his attention is diverted, it will be found that in tabetic and otherwise hypotonic patients the tendon is remarkably soft and easily compressed.

The plantar jerk is a typical representative of the skin reflex, as well as the most constant one. We have never found it absent without adequate attributable cause, such as disease of the peripheral nerves. In profound neurasthenia this reflex is considerably diminished, it is true, but it is never absent. In examining this reflex it is well to make a difference between strong and mild stimulation, and between the stroking and the sticking reflex. In the first group of cases examined attention was paid only to its presence or absence, and no particular notice was taken of the succession of events constituting the reflex phenomena. At this time it was found, as has already been observed by others, that the tendon reflex and the skin reflex show a peculiar dissociation. With increase of the tendon reflex there is usually a diminution or abolition of the skin reflex, but the reverse of this is not so unconditionally true. It was further remarked that this reflex is to a great extent dependent upon the state of the susceptibility of the part irritated. This is abundantly illustrated in cases of tabes. Here the plantar reflex is frequently delayed or duplicated, and one ought, therefore, to wait at least one minute before he pronounces that the plantar reflex is absent. A further interesting clinical phenomenon that is helpful in concluding as to the nature and location of a spinal lesion is the fact that total anesthesia and total motor paralysis do not involve the plantar reflex, so that the conduction to the particular anterior horn cells by means of the reflex medullary arc is not disturbed, while conduction of the same stimulus to the sensory centers is interfered with. And so it is explained that this reflex is the only evidence of the reflex activity left after total transverse section of the cord.

After attention was attracted to the symptomatic importance of the reflex observed by Babinski, a large number of examinations was made to determine the succession of events constituting it, *i. e.*, the "Babinski reflex," and from our observations the following seems to be the physiological formula: After mild stimulation of the plantar surface in normal individuals the first response is a slight contraction of the quadriceps imparted through and determined by contraction of the tensor fascia lata. The next incident is a flexion of the four smaller toes, with plantar flexion of the foot and dorsi-flexion of the big toe, slight flexion of the knee and hip, and abduction of the latter. The phenomenon that has been so far of the greatest clinical importance is the response of the toes. The physiological condition of this response consists of a more or less vigorous plantar flexion of the four smaller toes. When the reflexes are exaggerated, all toes, including the big one, flex. In disease of the pyramidal tracts this formula is reversed, and in varying degree. There may, in mild lesions, be only a slight transitory flexion of all the toes, and in well-defined cases of disease of the pyramidal tracts the first response noticed is a transitory dorso-flexion of the big toe. This, manifestly, is the cause of the hyperextension of the toes so frequently found in spastic states. From our observations we have corroborated the findings of Babinski, van Gehuchten, Collier, and others, that this type of plantar reflex is not found in normal individuals, and that when carefully examined with the precautions mentioned above, it is found only in cases in which there is unmistakable evidences of disease of the pyramidal tracts.

Finally, the writers desire to say a word anent the customary ways of examining the knee reflex. With most observers, the examination is undertaken simply to ascertain its presence or absence, while no particular note is taken of the quality of the response or of the behavior of the reflex after repeated elicitation. Bearing this in mind, we feel justified in stating that in a number of instances this reflex shows a peculiarly whimsical and interrupted behavior after repeated examinations. When a number of tappings are made in succession, one will find that the responses vary in intensity in a considerable degree, or that here and there one reflex is missing, and before that it may have been suppressed. If one is attentive at the same time to the palpitory impression received from the tendon, he will find that this whimsical reflex often coincides with a very soft tendon.

DISCUSSION.*

Dr. S. Weir Mitchell said he had listened with interest to this paper, and it was on a subject to which he had given much

---

*This discussion refers also to the paper by Drs. Walton and Paul, p. 305, *et seq.*

thought. After Jendrassik discovered the simple fact that to shut the hand firmly increased the knee-jerk, he dropped the subject. It was taken up by Dr. Mitchell, and, with Dr. Morris Lewis, carefully studied. They showed that all muscle acts reinforce the knee-jerk. They discovered that all forms of sensory excitement do the same—and much else which no foreign text-books remember to use. Lombard followed with laboratory confirmation and brilliant additions. Bowditch discovered the secondary inhibition, or lessening causes. The studies by Drs. Mitchell and Lewis of muscle-jerk, etc., and other American papers, followed. In fact this whole study has been the work of the two former observers, and the results long ago made clear are being continually rediscovered.

Dr. Collins had spoken of muscular tone. It is really a double contribution, as Drs. Mitchell and Lewis have proved. First there is the inherent muscle quality which causes a muscle to move when struck. This is still seen in muscle isolated from the centers. In muscle normally connected with the spine there is also a contributory tension of muscle due to central influence, for if a blow on muscle causes it to move, all agencies which reinforce knee-jerk add vigor to muscle-jerk. But the knee-jerk due to a pull on the muscle, requires also some mechanical tension to be effective and is so much more delicate than direct muscle-jerk as to be easily lost; but the phenomena are alike in kind.

There are many unsolved problems; the blow of a hammer on tendon or muscle causes movement capable of being reinforced by remote movement or sensation. But electrically excited motion of muscle is not thus capable. Why, is not known. Again, if knee-jerk be a reflex act, as it seems to be, and reinforcible, why are not the skin-muscle reflexes susceptible of such additions? Again, in some spinal diseases you can reinforce enfeebled knee-jerks by motion at a distance and not by sensation, or the reverse of this may be true. What, then, are the tracts of reinforcement?

Again, how can we explain the absence of these reflexes in some normal people? In them, as no one has yet pointed out, the muscle-jerk exists, but is not reinforcible; in other words, is not fed with spinal tension tone.

Dr. Mitchell concluded by saying that he feared that in place of helping he had simply increased the difficulties which surround this subject, but that when you increased difficulty you increased interest, and with a body like this, this was the right thing to do.

Dr. P. C. Knapp said that there were two other peculiarities about the skin reflexes which Dr. Mitchell might have mentioned. The first is, why are they so persistent in tabes; the second, why, with the exaggeration of muscle-muscle reflexes in hemiplegia and spastic conditions, the skin reflexes are often diminished.

The question of plantar reflexes, which had been dwelt upon by Dr. Collins and Dr. Walton, was one which had interested Dr. Knapp particularly of late, and he was much more disposed to agree with Dr. Collins, in believing that the plantar reflex was almost always present in health, than he was with Dr. Walton. He had not tested it very often in healthy people, but certainly in testing it in people who are sick, he had found hardly a case where the plantar reflex was absent unless there were some pretty definite reasons therefor, due to some change in the nervous condition.

Dr. Collins had hinted at a partial explanation of this. In some cases the stroking stimulus is insufficient to produce it, it requires the sticking stimulus or the summation of irritation, the irritation of a long-continued stimulus. In other cases there are not special movements of the toes, but we find a fascia lata reflex, which is a little more difficult to observe, since the patient must be completely stripped. In other cases still we may observe a purposive movement of withdrawal, which Dr. Knapp had found without apparent clinical significance in a number of cases, where there was not the normal flexion of the toes. In a few instances, especially in cases of chorea and in neurasthenic and hysterical conditions, he had found extension of the small toes without extension of the great toe.

There are two or three points with regard to the Babinski phenomenon pure and simple, which are worthy of mention. In the majority of cases, of course, it seems an indication of trouble in the pyramidal tract. Dr. Knapp recalled one case showing the Babinski phenomenon, where there was at first a diagnosis of tabes, but which proved to be double sciatica with muscular degeneration and paralysis of the extensor of the foot. In that case stimulation of the sole caused the Babinski phenomenon. He had found other cases with exaggeration of the deep reflexes, such as amyotropic lateral sclerosis, where there was no Babinski reflex, but a normal flexion. In regard to the period of time in which the Babinski phenomenon may develop he had seen a few weeks ago a case of extra-dural hemorrhage, with an enormous hemorrhage pressing on the brain, the clot being at least an inch and a half thick. He had seen the man four hours after the accident and three hours after the onset of the coma and hemiplegia. At that time there was a Babinski reflex in the paralyzed leg. Dr. Lothrop trephined and removed the clot about nine o'clock that evening, and the next morning the man had recovered completely from the paralysis and there was the normal flexion reflex.

A second case, however, was more important, although he could not explain it. An old hemiplegic with contracture had a Babinski reflex in the paralyzed leg, and the normal flexion reflex in the unparalyzed leg; but on stimulating the unparalyzed leg it produced normal flexion in the great toe of that leg and also normal flexion in the paralyzed leg.

Dr. Knapp could not agree with Dr. Walton that the plantar reflex is often unlike on the two sides. He had not found such a difference unless there was some disease of the nervous system.

Dr. B. Sachs said that it was a curious fact how often this question of reflexes is gone over again and again; we have been treated to the same facts that we heard ten or twelve years ago, with the exception of the Babinski phenomenon.

He wished to recall that twelve years ago he wrote to Dr. Mitchell about a case in which the tonus of the muscle was remarkably preserved, while the knee-jerk had disappeared, and Dr. Mitchell kindly sent him in return some "curves," showing that muscle tonus and deep-reflex were entirely independent of each other. He did not know whether Dr. Mitchell still holds to this view. As for himself he could not help feeling that hypotonus and lost reflex are coincident phenomena depending upon a lesion either in the spinal cord or in the peripheral nerve. He had this to add with reference to the Babinski phenomenon. He had observed it carefully in children and thought that it was a most unreliable feature in children. He had not been able to get any satisfaction in children up to years of nine and ten. He regarded the reflex as useful, but a very careful study will have to be made before we can give it the same value that we now attach to the knee-jerk and plantar reflexes.

Dr. W. G. Spiller referred to some observations he had recently made in two cases of hemiplegia. One patient was seen about one week after the hemiplegia developed. In each case the knee-jerk was absent, and the Babinski reflex was very pronounced; and in one case, at least, the knee-jerk did not return two or three weeks after the hemiplegia developed. Both patients died. Two cases are not sufficient to draw conclusions from, but Dr. Spiller believed that in recent cases of hemiplegia in which the knee-jerk was found absent several days or weeks after the hemiplegia had developed and the Babinski reflex was present prognosis was bad. It would be desirable if attention were paid to this combination of symptoms.

He had seen a case of amyotrophic lateral sclerosis in which the atrophy of the hand muscles was very marked, the knee-jerks were much exaggerated and the Babinski reflex was not present. In another case many symptoms of tabes were present, but the knee-jerks were exaggerated and the Babinski reflex was absent. This was probably a case of spinal syphilis. In a case of fracture of the spinal vertebræ with paraplegia, Dr. Spiller had observed extension of the great toe of one side with flexion of the other toes of the same foot. The Babinski reflex he regarded as of considerable value in connection with other signs, but it was doubtful whether it could be looked upon as pathognomonic of lesion of the pyramidal tract.

Dr. F. W. Langdon said that in his experience the plantar reflex had been actually absent with extreme rarity, possibly not more than in one or two cases in one hundred; and in cases where it had been *apparently* absent, it had been proven to be present subsequently by carefully testing the patient, without letting him know when it was to be done. Therefore, when Dr. Langdon intended to make a test in a doubtful case he would direct the interne or nurse to leave the patient uncovered and blindfolded, and the test would be made unexpectedly to the patient. Dr. Langdon had found Babinski's phenomenon an exceedingly reliable clinical sign, and it had been of service to him in a number of cases where the knee-jerk was of very doubtful value. He considered it, therefore, a sign of considerable clinical importance.

TUMOR OF THE PARIETAL CONVOLUTION, ACCURATELY LOCALIZED AND REMOVED BY OPERATION.

By C. K. Mills, M.D., and W. W. Keen, M.D.

(*See p.* 244).

DISCUSSION.

Dr. F. X. Dercum said that this, to his mind, was one of the most instructive cases that he had ever seen. Too much credit cannot be given to Dr. Mills for the brilliant and successful outcome of the case. Dr. Dercum saw the patient in 1898, two years before the operation. He was then simply somewhat depressed, but outside of an accentuated second sound of the heart, he presented not a single physical sign. He had, however, one subjective symptom, namely, an occasional mouse-like sensation starting from the head and extending to the arm. The symptom of astereognosis was of very great value in localization. Dr. Dercum was quite certain that the symptom of astereognosis is not as much studied as it should be. He was surprised to find in his wards at Bockley, in going over 114 miscellaneous cases, thirty-one that presented the symptoms of astereognosis. It seemed also to be possible to determine in most cases, when it was present, whether it was cortical or peripheral in origin.

Dr. G. L. Walton said it was of interest to place on record all such cases of established tumor, in the absence of headache, vomiting and optic neuritis. Though this possibility is recognized, it requires courage in the given case to make a confident diagnosis, and to act on the conviction. He had recently seen a case illustrating this difficulty. An elderly man had twitching in the flexors of the left wrist, followed by paralysis, then twitching in the extensors, followed by paralysis gradually involving the whole arm and leg without further spasm. The trouble came on six months ago, but there has been no headache, vomiting, or optic neuritis. Dr. Keen and Dr. Peterson were consulted by letter, and on the same data the former diagnosticated tumor, and favored operation; the latter regarded the case as one of thrombosis, and deemed operation unjustifiable. Dr. Richardson and Dr. Walton favored the diagnosis of tumor, and favored exploratory operation, but felt no confidence in the diagnosis, or prospect of relief. During the past week chills, restlessness and fever, and optic neuritis had appeared. In view of the evidently terminal nature of the present symptoms all idea of operation has been abandoned, but the optic neuritis favors the diagnosis of tumor, and probably a diffuse glioma.

---

75. THE DEVELOPMENT OF VOLUNTARY MOVEMENT. E. A. Kirkpatrick (Psychological Review, 6, 1899, p. 275).

This is a brief discussion of an interesting topic in human genetic psychology, a topic still much in need of study based on observation.

The three theories of the attainment of the power of motor control are mentioned, the first, popular in its status, that the child learns how to make movements; the second, that the capability of making these movements is inherited just as in the case of the chick, and the third, "that the movements are partially provided for by the inherited mechanism and partly acquired and learned"; of these the author favors the last, while admitting that the second has many facts in its favor.

There is obviously, Dr. Kirkpatrick thinks, "an inherited physiological space-relation between the visual stimulus of an object in a certain position and the muscles for moving to that object." This physiological space-relation is deemed to be of an hitherto unappreciated importance in explaining not only the development of voluntary movements, but spatial ideas as well. In the first graspings and reachings, visual sensations alone are employed, but later on the joint and muscle and tactile sensations already experienced are helpful and important to further advance in the coördination of movements. "Chance" is shown to be of insignificant effect because of the mechanical complexity of the neuro-muscular organism. The child does not properly try to combine the elements of a movement and (as is the case with later and adult actions) does the movement more easily and better when least in the deliberate consciousness. The advantages of allowing free scope to the inherited spontaneity of action have important application in all forms of manual training and in active educational processes in general. DEARBORN.